REMARKS

In the Office Action, claims 8, 10-14 and 16-26 are rejected under 35 U.S.C. §112, first paragraph; claims 8, 10-14, and 16-26 have been rejected under 35 U.S.C. §103. Applicants respectfully disagree with and traverse the rejections for the reasons set forth below.

Regarding the §112 rejection, the Patent Office, while concluding that the specification is enabling for a fuel electrode (or an oxygen electrode) with a range of about 2 to about 4 μm, alleges that one skilled in the art would not be able to practice the claimed invention that includes, in part, an electrode with a thickness of less than about 2 μm.

On page 7, lines 31-32 of the specification, Applicants have provided a prophetic working example that the fuel electrode 2 and the oxygen electrode 3 "may be of an extremely thin thickness of, for example, ranging from about 2 to about 4 μm." First, compliance with the enablement requirement of 35 U.S.C. §112, first paragraph, does not turn on whether an example is disclosed. See, MPEP §2164.02. Second, in order to make a valid §112 rejection based on one prophetic example, one must evaluate all the facts and evidence and state why one would not expect to be able to extrapolate that one example (i.e., about 2 to about 4 μm) across the entire scope of the claims (i.e., less than 5 μm). See, MPEP, §2164.02. Furthermore, as long as the specification discloses at least one method for making and using the claimed invention that bears a reasonable correlation to the entire scope of the claim, then the enablement requirement of §112 is satisfied. See, MPEP §2164.01(b).

Applicants have disclosed a method of making the fuel or oxygen electrode that includes dripping or spraying a solution containing, for example, carbon nanotubes with a diameter of approximately 1 nm in diameter directly onto an electrolyte film. See, Specification, p. 7, lines 13-28. As the carbon nanotubes have an extremely small diameter (i.e., 1 nm) a layer of any desired thinness may be formed. Applicants have also disclosed that reducing the thickness of the electrodes improves cell performance. See, Specification, p. 2, lines 24-26. Therefore, Applicants believe that one skilled in the art should be able to readily practice the claimed invention as presently defined and claimed.

To the extent that the Patent Office maintains that the claim term "less than 5 μm" is not enabled, Applicants again respectfully disagree. Again, Applicants refer the Patent Office to the originally filed claims, in particular claim 2 which recites that at least one of the fuel electrode

and the oxygen electrode containing the fibrous carbonaceous material has a thickness which is no greater than 5 μm. Clearly, this provides sufficient description and support when read in the context of the specification such that one skilled in the art would readily understand and be able to practice the claimed invention that is defined, in part, by a gas diffusion electrode thickness of less than 5 μm.

Accordingly, Applicants respectfully request that the rejection under 35 U.S.C. §112, first paragraph, be withdrawn.

In the Office Action, claims 8, 10-14, and 16-32 are rejected under 35 U.S.C. §103. More specifically, claims 8, 10, 14, 16-18, 20, 21 and 26 are rejected in view of U.S. Patent No. 6,589,682 ("Fleckner") as evidenced by US 2003/0048057 ("Oyama"); claims 8, 11, 14, 16, 21 and 23 are rejected in view of US 6,013,371 ("Hager") in view of U.S. Patent No. 5,861,222 ("Fischer") as evidenced by Kordesch et al.; and claims 12, 13, 19, 22, 24 and 25 are rejected in view of Fleckner and Newman and further in view of Hager. Applicants believe that the obviousness rejections are improper for at least those reasons as detailed below.

At the outset, the Patent Office primarily relies on Fleckner or Hager in support of the obviousness rejections. With respect to Fleckner, clearly this reference is distinguishable from the claimed invention.

Of the pending claims at issue, claims 8, 14 and 21 are the sole independent claims. Claim 8 recites a gas diffusion electrode operable within a fuel cell that includes a fibrous carbonaceous material wherein the gas diffusion electrode includes a thickness of less than 5 μm. Claim 14 recites a fuel cell that at least includes a proton conductor disposed between a first electrode and a second electrode wherein at least one of the first electrode and the second electrode includes a fibrous carbonaceous material that is formed on the proton conductor and wherein at least one of the first electrode and the second electrode includes a thickness of less than 5 μm. Claim 21 recites a fuel cell that includes, in part, at least one of a first electrode and a second electrode that includes a carbonaceous material wherein at least one of the first electrode and the second electrode includes a thickness of less than 5 μm.

According to the present invention, the fibrous carbonaceous material can be directly formed on the proton conductor. In this regard, it is not necessary to separately handle the fuel electrode and/or the oxygen electrode and thus the mechanical strength of the electrodes does not

have to be taken into consideration. Therefore, the electrodes may be reduced in thickness. This can enhance the cell reaction and improve cell performance. See, Specification, p. 2, lines 19-26.

Applicants believe that Fleckner is deficient with respect to the claimed invention for at least a number of reasons. Fleckner fails to even mention the thickness requirements of the alleged gas diffusion electrode (100, 102) as even admitted by the Patent Office. See, Office Action, page 3. Indeed, Applicants have discovered that the fuel electrode and oxygen electrode are not required to be independent films, and thus, are not required to exhibit mechanical strength. In this regard, the thickness of the electrodes can be extremely thin, such as less than 5 μm. In contrast, Fleckner emphasizes the need for the GDL to exhibit improved mechanical strength. Fleckner notes that "one of the advantages of using fullerenes to deliver fuel and oxidizer to the catalytic electrodes of the [alleged] novel fuel cells disclosed herein is that of greater structural rigidity." See, Fleckner, col. 6, lines 60-64. Fleckner goes on to say that the GDLs are susceptible to crushing, and that the aligned nature of the nanotubes helps prevent crushing. See, Fleckner, col. 7, lines 5-7. Therefore, Fleckner teaches away from the desirability of creating ultra thin GDL layers because they are susceptible to crushing and require increased structural rigidity. Simply because Fleckner discloses that the length of the nanotubes is controllable does not imply or suggest the desirability of an extremely thin GDL. Therefore, it would not be obvious, to one skilled in the art to make an extremely thin GDL layer, such as less than 5 μm.

Furthermore, Fleckner does not disclose or suggest that the gas diffusion electrode composed of a carbonaceous material, such as a fibrous carbonaceous material, can be directly formed on the proton conductor material, such as an electrolyte film. In contrast, Fleckner discloses a catalytic electrode layer that is sandwiched between the GDL and the proton conductor. See, Fleckner, col. 5, lines 57-66. Fleckner lists additional ways in which the GDL may be formed, none of which suggest applying the nanotubes to the proton conductor. For example, one disclosed method of forming the GDL provides that aligned arrays of fullerenes can be adhered to the surfaces of the flow field plate (FFP). See, Fleckner, column 6, lines 53-56. Alternatively, the GDLs can be fabricated by affixing the nanotubes to a conventional, porous GDL material such as Teflon-impregnated carbon paper, an aerogel, or a carbon fibermat.

See, Fleckner, col. 7, lines 1-5. Nowhere does Fleckner suggest that the GDL may be formed on the proton conductor.

Again, Applicants have advantageously discovered that the fibrous carbonaceous material can be directly formed as one or both of the fuel and oxygen electrodes on the proton conductor, and thus, separate handling of the fuel and/or oxygen electrodes is not required. Moreover, Applicants have demonstrated that a fuel cell that incorporates the electrodes has a superior performance, such as an output of approximately 100 mW, 0.6 V, and further can be more easily manufactured by forming the fuel and/or oxygen electrode directly on the proton conductor. See, Specification, page 7, line 29 to page 8, line 5. Thus, Applicants believe that Fleckner is clearly distinguishable from the claimed invention for at least these reasons.

Further, Applicants do not believe that the remaining cited art relied on by the Patent Office in support of Fleckner can be utilized to remedy the deficiencies of Fleckner. For example, assuming arguendo that Oyama can even be asserted as prior art, which Applicants question, the Patent Office merely relies on Oyama for its alleged teaching regarding a fibrous carbon material. See, Office Action, page 4. With respect to Newman and Hager, the Patent Office merely relies on the teachings of same as they purportedly relate to a fibrous carbonaceous material that includes a mixture of carbon nanotubes and vapor grown carbon fibers. Therefore, even if combinable, Applicants do not believe that one skilled in the art would be inclined to modify Fleckner to arrive at the claimed invention in view of what Oyama, Newman and Hager allegedly disclose.

As previously discussed, the Patent Office has also primarily relied on Hager in support of the obviousness rejection with respect to claims 8, 11, 14, 16, 21 and 23. As even admitted by the Patent Office, the Hager reference fails to provide the thickness of the gas diffusion electrode for use in a fuel cell. See, Office Action, p. 5. As previously discussed, independent claims 8, 14 and 21 have been amended to recite, in part, that the electrode has a thickness of less than 5 μm.

Further, Applicants do not believe that Fischer and Kordesch can be relied on solely to remedy this deficiency of Hager. In Fischer, the electrode includes a proton-conducting polymer membrane with an electro-catalyst dispersed therein. See, Fischer, column 4, lines 32-39. Indeed, the preferred proton connecting polymer includes a fluorocarbon vinyl ether polymer

(see, Fischer, column 4, lines 40-42), and further discloses that at a thickness of less than 5 μm, the electrode becomes increasingly less cohesive due to its high porosity (see Fischer, column 5, lines 56-58). Clearly, this suggests that Fischer is distinguishable from the claimed invention to the extent that it effectively teaches away from the claimed invention that recites, in part, a gas diffusion electrode within a fuel cell that has a thickness of less than 5 μm. Moreover, the Patent Office merely relies on Kordesch for its alleged teaching that a proton conducting material is sandwiched between an anode and a cathode in a fuel cell. See, Office Action, page 6. Therefore, even if combinable, Applicants believe that one skilled in the art would not be inclined to modify Hager in view of Fischer and Kordesch to arrive at the claimed invention.

As previously discussed, the references cited by the Patent Office each fail to motivate one skilled in the art to combine and/or modify the teachings of the references to reconstruct the claimed invention. Instead, the Patent Office has relied on hindsight reconstruction of the claimed invention, thus using the claimed invention as a template for reconstruction thereof. Indeed, the Patent Office attempts to modify the teachings of Fleckner or Fischer in combination with other references, where both Fleckner and Fischer teach away from a gas diffusion electrode including a fibrous carbonaceous material, wherein the electrode is less than 5 μm as claimed and discussed above.

In one example, the Patent Office bases the combination of Fischer and Hager on their alleged common teaching regarding a gas diffusion electrode. However, Fischer teaches a gas diffusion electrode containing an electrocatalyst which is dispersed in a proton conducting isomer and which has a porosity between 40 and 75%. Fischer speaks of an optimal electrode thickness that is based on this particular composition. However, the Patent Office suggests that the person skilled in the art of manufacturing nanotube based fuel cell electrodes as suggested in Hager, would look to Fischer to determine the optimal thickness of the nanotube electrode. As compared to nanotubes, the electrodes in Fischer are composed of a completely different chemical and physical composition with dimensional stability limited by its porosity. See, Fischer, col. 5, lines 56-60. Thus, it would make no sense to apply experimental data, and the like from Fischer to modify Hager. For this reason, and for at least the reasons discussed above, one skilled in the art would not be motivated to modify the cited art to purportedly reconstruct the claimed invention.

Based on at least those reasons above, Applicants believe that the cited art is distinguishable with respect to the claimed invention. Therefore, Applicants believe that the cited art, even if combinable, fails to render obvious the claimed invention.

Accordingly, Applicants respectfully request that the obviousness rejections with respect to claims 8, 10-14 and 16-26 be withdrawn.

For the foregoing reasons, Applicants believe that the present application is in condition for allowance and earnestly solicit reconsideration of same.

Respectfully submitted,

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